

Bluetooth® Qualification

TEST REPORT

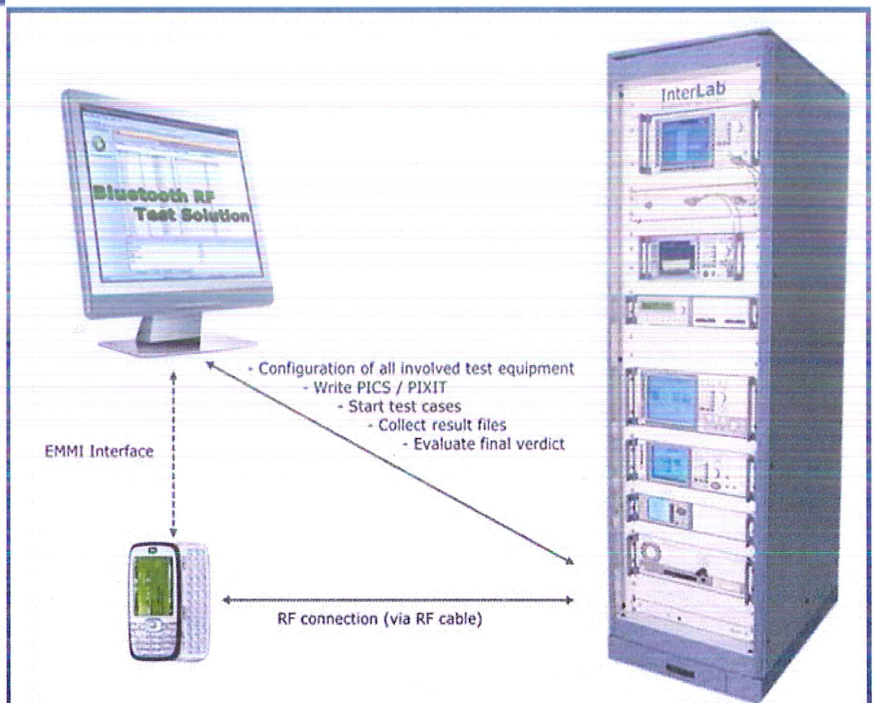
ISSUED BY
Shenzhen BALUN Technology Co., Ltd.



FOR
Apollo4Blue

ISSUED TO
Ambiq Micro Inc.

6500 River Place Blvd. Building 7, Suite 200



Tested by: Zhao Yangyang
Zhao Yangyang

Date Oct. 29, 2020

Approved by: Tolan Tu

Tolan Tu
(Testing Director)

Date Oct. 29, 2020

Report No.: BL-SZ20A0203-801

EUT Type: Apollo4Blue

Model Name: Apollo4 Blue

Brand Name: Ambiq

Test Conclusion: Pass

Test Date: Oct. 16, 2020 ~ Oct. 26, 2020

Date of Issue: Oct. 29, 2020

NOTE: This test report of test results only related to testing samples, which can be duplicated completely for the legal use with the approval of the applicant; it shall not be reproduced except in full, without the written approval of Shenzhen BALUN Technology Co., Ltd. BALUN Laboratory. Any objections should be raised within thirty days from the date of issue. To validate the report, please contact us.

Revision History

<u>Version</u>	<u>Issue Date</u>	<u>Revisions Content</u>
<u>Rev. 01</u>	<u>Oct. 29, 2020</u>	<u>Initial Issue</u>

TABLE OF CONTENTS

1 GENERAL INFORMATION.....	3
1.1 Identification of the Testing Laboratory.....	3
1.2 Identification of the Responsible Testing Location.....	3
1.3 Test Environment Condition.....	3
1.4 Announce.....	3
2 PRODUCT INFORMATION.....	4
2.1 Applicant Information.....	4
2.2 Manufacturer Information.....	4
2.3 Factory Information.....	4
2.4 General Description for Equipment under Test (EUT).....	4
2.5 Ancillary Equipment.....	4
2.6 Technical Information.....	5
3 SUMMARY OF TEST RESULTS.....	9
3.1 Test Standards.....	9
3.2 Summary of Test Results.....	10
4 GENERAL TEST CONFIGURATIONS.....	11
4.1 Test Condition.....	11
4.2 Test Equipment List.....	11
4.3 Test Setup.....	12
5 RF-PHY CONFORMANCE TEST RESULTS.....	14
5.1 RF-PHY ICS /IXIT (Bluetooth Low Energy).....	14
5.2 Test Results List.....	18
ANNEX A EUT PHOTOS.....	19

1 GENERAL INFORMATION

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100
Fax Number	+86 755 6182 4271

1.2 Identification of the Responsible Testing Location

Test Location 1	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has passed the accreditation by China National Accreditation Service for Conformity Assessment (CNAS). The accreditation number is L6791. The laboratory has passed the accreditation by Bluetooth SIG for BQTF.
Description	All measurement facilities used to collect the measurement data are located at Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China.

1.3 Test Environment Condition

Ambient Pressure	100 to 102 KPa
Ambient Temperature	19 to 25 °C
Ambient Relative Humidity	45 to 55 %

1.4 Announce

- (1) The test report reference to the report template version v6.0.
- (2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.
- (3) The test report is invalid if there is any evidence and/or falsification.
- (4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.
- (5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.
- (6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.
- (7) Bluetooth is a Trademark owned by Bluetooth SIG, Inc. and licensed to Shenzhen BALUN Technology Co., Ltd.
- (8) The laboratory is only responsible for the data released by the laboratory, except for the part provided by the applicant.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Ambiq Micro Inc.
Address	6500 River Place Blvd. Building 7, Suite 200

2.2 Manufacturer Information

Manufacturer	Ambiq Micro Inc.
Address	6500 River Place Blvd. Building 7, Suite 200

2.3 Factory Information

Factory	N/A
Address	N/A

2.4 General Description for Equipment under Test (EUT)

Bluetooth Core Specification Version	Bluetooth Core Version 5.1
Product Type	Component
Model Name Under Test	Apollo4 Blue
Hardware Version	Rev A2
Software Version	R1.09 rc5
Brief Description	Ultra low power Bluetooth low energy System on Chip.

2.5 Ancillary Equipment

N/A

2.6 Technical Information

CORE PROTOCOLS			
Support [Yes] or [No]	Protocol / Profile		Reference
No	RF	Radio	Vol 2, Part A
No	BB	Baseband	Vol 2, Part B
No	LMP	Link Manager	Vol 2, Part C
No	80211PAL	802.11 Protocol Adaptation Layer	Vol 5, Part A
No	80211 MAC-PHY	802.11 MAC/PHY	IEEE 802.11-2007
No	HCI	Host Controller Interface	Vol 2, Part E
No	AMPHCI	AMP Host Controller Interface	Vol 5, Part A
No	L2CAP	Logical Link Control and Adaptation Protocol	Vol 3, Part A
No	A2MP	AMP Manager Protocol	Vol 3, Part E
No	SDP	Service Discovery Protocol	Vol 3, Part B
No	GAP	Generic Access Profile	Vol 3, Part C
No	IAL	Isochronous Adaptation Layer	Vol 6, Part G
Yes	LL	Link Layer	Vol 6, Part B
Yes	RFPHY	RF PHY	Vol 6, Part A
Yes	4.0HCI	4.0 Host Controller Interface	Vol 3, Part E
No	GATT	Generic Attribute Profile	Vol 3, Part G
No	ATT	Attribute Protocol	Vol 3, Part H
No	SM	Security Manager Protocol	Vol 3, Part F

Bluetooth External to Core Protocols and Profiles			
Support [Yes] or [No]	Protocol / Profile		Reference
No	3DSP	3D Synchronization Profile	External to Core
No	A2DP	Advanced Audio Distribution Profile	External to Core
No	AIOP	Automation IO Profile	External to Core
No	AIOS	Automation IO Service	External to Core
No	ANP	Alert Notification Profile	External to Core
No	ANS	Alert Notification Service	External to Core
No	AVCTP	Audio/Video Control Transport Protocol	External to Core
No	AVDTP	Audio/Video Distribution Transport Protocol	External to Core
No	AVRCP	Audio/Video Remote Control Profile	External to Core
No	BAS	Battery Service	External to Core
No	BCS	Body Composition Service	External to Core
No	BIP	Basic Imaging Profile	External to Core
No	BLP	Blood Pressure Profile	External to Core
No	BLS	Blood Pressure Service	External to Core
No	BMS	Bond Management Service	External to Core
No	BNEP	Bluetooth Network Encapsulation Protocol	External to Core
No	BPP	Basic Printing Profile	External to Core
No	BSP	Binary Sensor Profile	External to Core
No	BSS	Binary Sensor Service	External to Core
No	CGMP	Continuous Glucose Monitoring Profile	External to Core
No	CGMS	Continuous Glucose Monitoring Service	External to Core
No	CPP	Cycling Power Profile	External to Core
No	CPS	Cycling Power Service	External to Core
No	CSCP	Cycling Speed and Cadence Profile	External to Core
No	CSCS	Cycling Speed and Cadence Service	External to Core
No	CTN	Calendar, Tasks and Notes Profile	External to Core
No	CTS	Current Time Service	External to Core
No	DID	Device ID Profile	External to Core
No	DIS	Device Information Service	External to Core
No	DUN	Dial-Up Networking Profile	External to Core
No	EMCS	Emergency Configuration Service	External to Core
No	EMP	Emergency Profile	External to Core
No	ESP	Environmental Sensing Profile	External to Core
No	ESS	Environmental Sensing Service	External to Core
No	FMP	Find Me Profile	External to Core
No	FTMP	Fitness Machine Profile	External to Core
No	FTMS	Fitness Machine Service	External to Core
No	FTP	File Transfer Profile	External to Core
No	GAVDP	Generic Audio/Video Distribution Profile	External to Core

No	GLP	Glucose Profile	External to Core
No	GLS	Glucose Service	External to Core
No	GNSS	Global Navigation Satellite Systems	External to Core
No	GOEP	Generic Object Exchange Profile	External to Core
No	GPP	Generic PIM Profile	External to Core
No	HCRP	Hardcopy Cable Replacement Profile	External to Core
No	HDP	Health Device Profile	External to Core
No	HFP	Hands-Free Profile	External to Core
No	HID	Human Interface Device	External to Core
No	HID 1.1	Human Interface Device 1.1	External to Core
No	HIDS	HID Service	External to Core
No	HOGP	HID over GATT Profile	External to Core
No	HPS	HTTP Proxy Service	External to Core
No	HRP	Heart Rate Profile	External to Core
No	HRS	Heart Rate Service	External to Core
No	HSP	Headset Profile	External to Core
No	HTP	Health Thermometer Profile	External to Core
No	HTS	Health Thermometer Service	External to Core
No	IAS	Immediate Alert Service	External to Core
No	IDP	Insulin Delivery Profile	External to Core
No	IDS	Insulin Delivery Service	External to Core
No	IOP	Interoperability Test Specification	External to Core
No	IPS	Indoor Positioning Service	External to Core
No	IPSP	Internet Protocol Support Profile	External to Core
No	LLS	Link Loss Service	External to Core
No	LNP	Location and Navigation Profile	External to Core
No	LNS	Location and Navigation Service	External to Core
No	MAP	Message Access Profile	External to Core
No	MCAP	Multi-Channel Adaptation Protocol	External to Core
No	MESH	Mesh Profile	External to Core
No	MMDL	Mesh Model	External to Core
No	MPS	Multi-Profile Specification	External to Core
No	NDCS	Next DST Change Service	External to Core
No	OPP	Object Push Profile	External to Core
No	OTP	Object Transfer Profile	External to Core
No	OTS	Object Transfer Service	External to Core
No	PAN	Personal Area Networking Profile	External to Core
No	PASP	Phone Alert Status Profile	External to Core
No	PASS	Phone Alert Status Service	External to Core
No	PBAP	Phone Book Access Profile	External to Core
No	PLXP	Pulse Oximeter Profile	External to Core
No	PLXS	Pulse Oximeter Service	External to Core
No	PXP	Proximity Profile	External to Core

No	RCP	Reconnection Configuration Profile	External to Core
No	RCS	Reconnection Configuration Service	External to Core
No	RFCOMM	RFCOMM with TS 07.10	External to Core
No	RSCP	Running Speed and Cadence Profile	External to Core
No	RSCS	Running Speed and Cadence Service	External to Core
No	RTUS	Reference Time Update Service	External to Core
No	SAP	SIM Access Profile	External to Core
No	SCPP	Scan Parameters Profile	External to Core
No	SCPS	Scan Parameters Service	External to Core
No	SDAP	Service Discovery Application Profile	External to Core
No	SPP	Serial Port Profile	External to Core
No	SYNC	Synchronization Profile	External to Core
No	TDS	Transport Discovery Service	External to Core
No	TIP	Time Profile	External to Core
No	TPS	Tx Power Service	External to Core
No	UDS	User Data Service	External to Core
No	VDP	Video Distribution Profile	External to Core
No	WSP	Weight Scale Service	External to Core
No	WSS	Weight Scale Profile	External to Core

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

Description	Document Version
TCRL BLE RF PHY Test Specification	TCRL 2019-2 RF-PHY.TS.p15

3.2 Summary of Test Results

Test Item	Test Verdict	Note
RF-PHY	PASS	See details in Section 5

4 GENERAL TEST CONFIGURATIONS

4.1 Test Condition

Environment Parameter	Selected Values During Tests	
	Temperature	Voltage
Normal Temperature, Normal Voltage (NTNV)	Ambient	DC 5V

4.2 Test Equipment List

4.2.1 RF Test System

7Layers Systems - InterLab Bluetooth RF Test Solution (InterLab BRTS)				
Equipment Name	Type	Serial No.	Manufacturer	Cal. Due Date
Power Sensor	NRP-Z21	103971	R&S	2021-06-07
Bluetooth Signaling Unit	CBT	101005	R&S	2021-06-07
Power Supply	HMP2020	018141664	R&S	2021-06-07
Frequency Signal Analyzer	FSL3	103640/003	R&S	2021-06-07
Vector Signal Generator	SMJ100A	1403.4507k02 /101859	R&S	2021-06-07
Signal Generator	SMF100A	1167.0000k02 /104260	R&S	2021-06-07
Switching Unit	TCOT	--	7Layers	--
Test Engine Software	SW ver. 5.1.4	--	7Layers	--

CTTL Systems - RTSB-A Test System				
Equipment Name	Type	Serial No.	Manufacturer	Cal. Due Date
Bluetooth Signaling Unit	CMW270	100607	R&S	2021-06-07
Frequency Signal Analyzer	FSV30	103118	R&S	2021-06-07
Vector Signal Generator	SMB100A	177746	R&S	2021-06-07
Signal Generator	SMBV100A	260592	R&S	2021-06-07
Switching Unit	RTSB-A	--	CTTL	--
Test Engine Software	SW ver. 3.0.0	--	CTTL	--

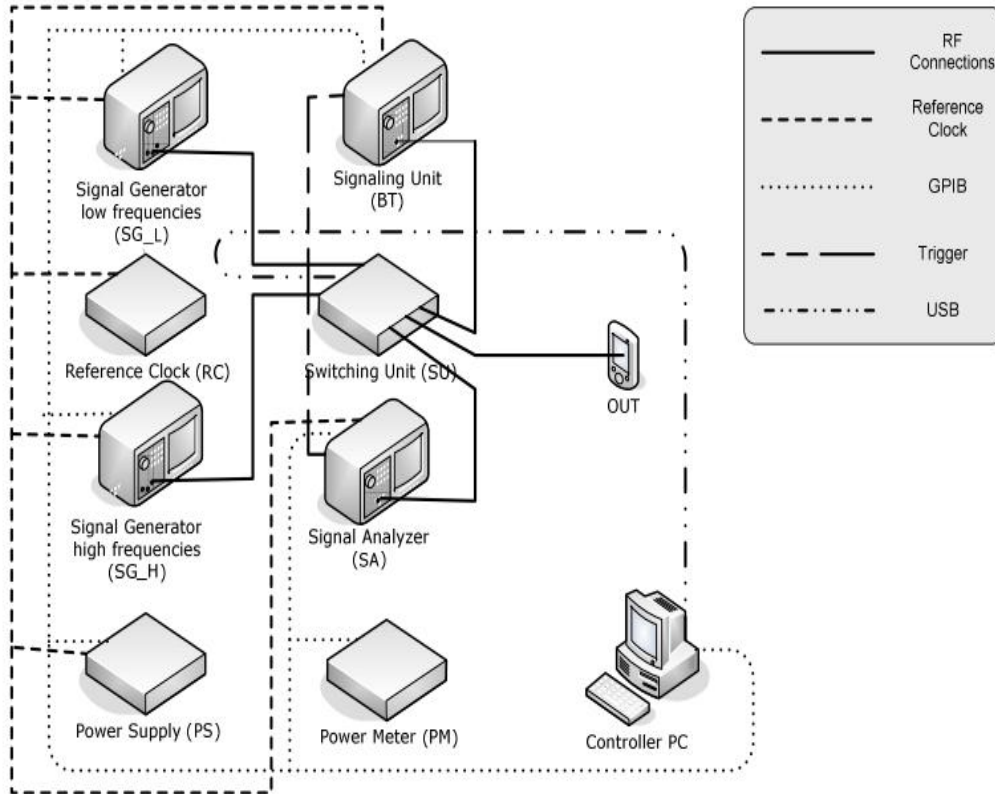
4.2.2 Profile Test System

Equipment Name	Type	Serial No.	Manufacturer	Cal. Date	Cal. Due
Profile Tuning Suite	N/A	N/A	Bluetooth SIG	N/A	N/A
PTS Dongle	N/A	N/A	Bluetooth SIG	N/A	N/A

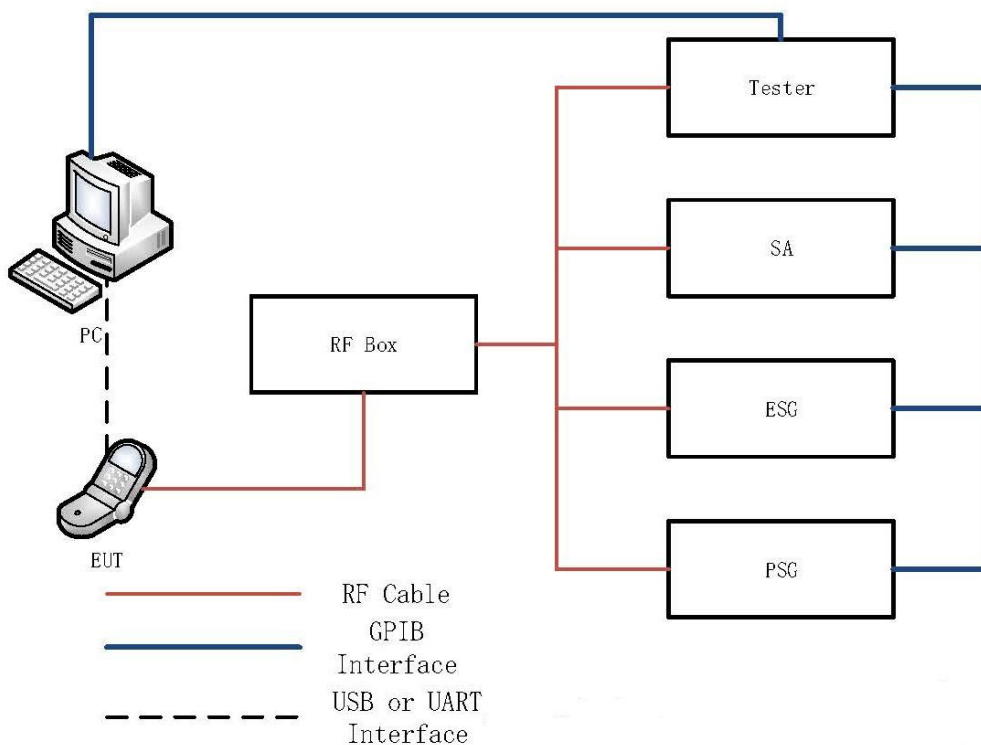
4.3 Test Setup

4.3.1 RF Test System

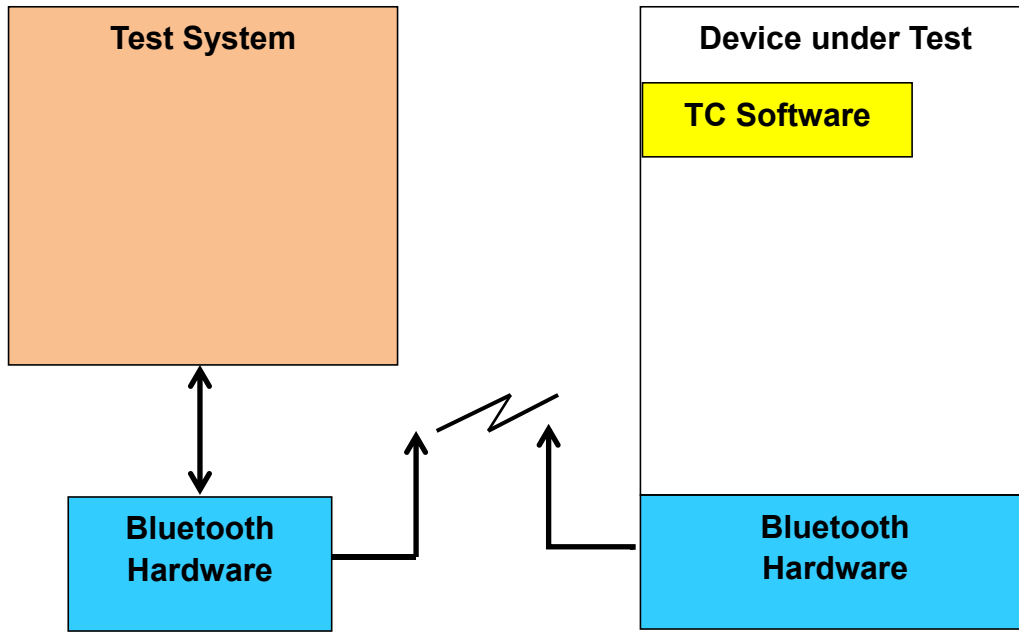
7Layers Systems - InterLab Bluetooth RF Test Solution (InterLab BRTS)



CTTL Systems - RTSB-A Test System



4.3.2 Profile Test System



5 RF-PHY CONFORMANCE TEST RESULTS

5.1 RF-PHY ICS /IXIT (Bluetooth Low Energy)

Bluetooth LE RF-PHY Capabilities				
Item	Capability	System Spec Reference	Status	Support [Yes] or [No]
1	LE Transmitter	[1], 3	C.1	Yes
2	LE Receiver	[1], 4	C.1	Yes
3	LE Transceiver	[1], 3, 4	C.1	Yes
4	LE 2M PHY	[3], 3, 4	C.2	Yes
5	Stable Modulation Index - Transmitter	[3], 3.1.1	C.3	No
6	Stable Modulation Index - Receiver	[3], 3.1.1	C.4	No
7	LE Coded PHY	[3], 3, 4	C.2	No
8	Transmitting Constant Tone Extensions	[4], 5	C.3	No
9	2 μ s Antenna Switching During Constant Tone Extension Transmission (AoD)	[4], 5	C.5	No
10	1 μ s Antenna Switching During Constant Tone Extension Transmission (AoD)	[4], 5	C.6	No
11	2 μ s Antenna Sampling During Constant Tone Extension Reception (AoD)	[4], 5	C.4	No
12	2 μ s Antenna Switching and Sampling During Constant Tone Extension Reception (AoA)	[4], 5	C.7	No
13	1 μ s Antenna Sampling During Constant Tone Extension Reception (AoA)	[4], 5	C.7	No
14	1 μ s Antenna Switching and Sampling During Constant Tone Extension Reception (AoA)	[4], 5	C.8	No

C.1: Mandatory to support at least one of these capabilities. Note that selecting both RF PHY 1/1 "LE Transmitter" and RF PHY 1/2 "LE Receiver" is equivalent to selecting RF PHY 1/3 "LE Transceiver" and vice versa.

C.2: Excluded IF SUM ICS 21/14 "Core v4.2" is supported, otherwise Optional.

C.3: Excluded IF SUM ICS 21/14 "Core v4.2" is supported, otherwise Optional IF RF PHY 1/1 "LE Transmitter" OR RF PHY 1/3 "LE Transceiver" is supported, otherwise Excluded.

C.4: Excluded IF SUM ICS 21/14 "Core v4.2" is supported, otherwise Optional IF RF PHY 1/2 "LE Receiver" OR RF PHY 1/3 "LE Transceiver" is supported, otherwise Excluded.

C.5: Optional IF RF PHY 1/8 "Transmitting Constant Tone Extensions" is supported, otherwise Excluded.

C.6: Optional IF RF-PHY 1/9 "2 μ s Antenna Switching During Constant Tone Extension Transmission (AoD)" is supported, otherwise Excluded.

C.7: Optional IF RF PHY 1/11 "2 μ s Antenna Sampling During Constant Tone Extension Reception (AoD)" is supported, otherwise Excluded.

C.8: Mandatory IF RF PHY 1/12 "2 μ s Antenna Switching and Sampling During Constant Tone Extension Reception (AoA)" and RF-PHY 1/13 "1 μ s Antenna Sampling During Constant Tone Extension Reception (AoD)" are supported, otherwise Excluded.

Bluetooth LE Test Interface Capabilities				
Item	Capability	System Spec Reference	Status	Support [Yes] or [No]
1	HCI Test Interface	[2], 2	C.1	Yes
2	UART Test Interface	[2], 3	C.1	No

C.1: At least one of the capabilities shall be supported.

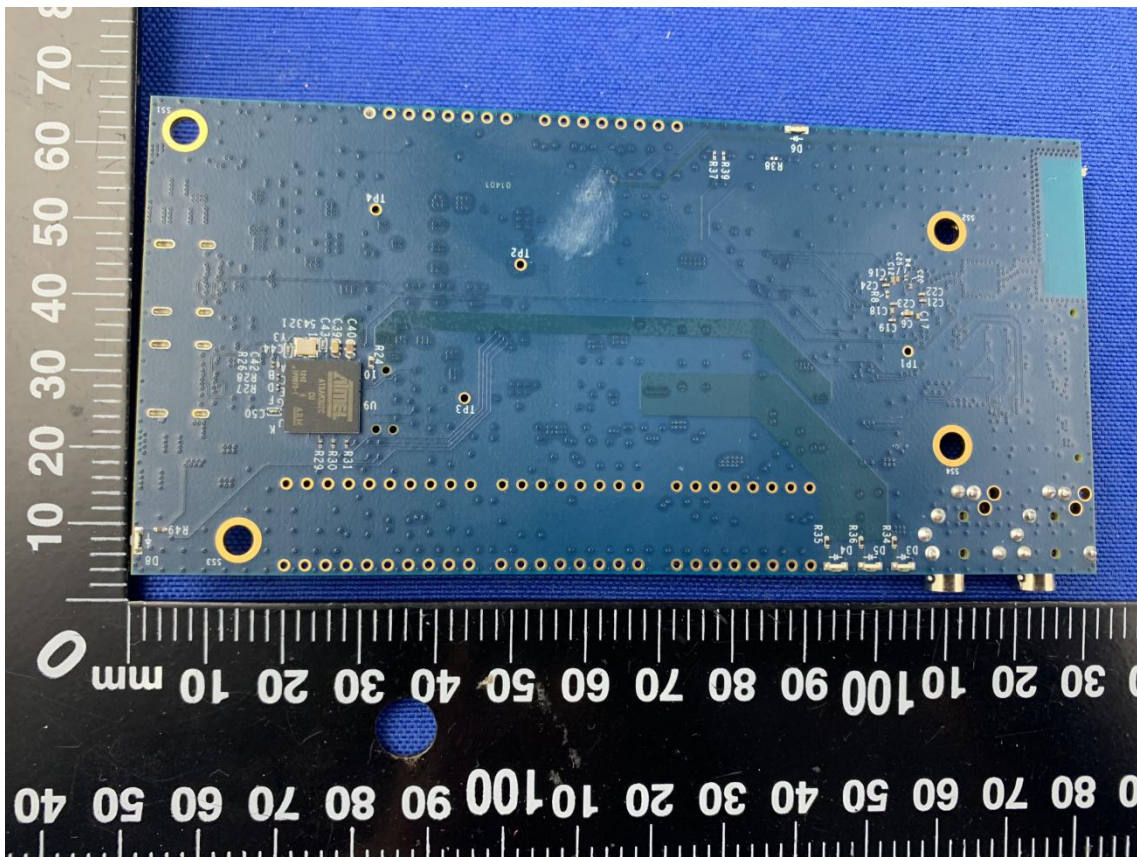
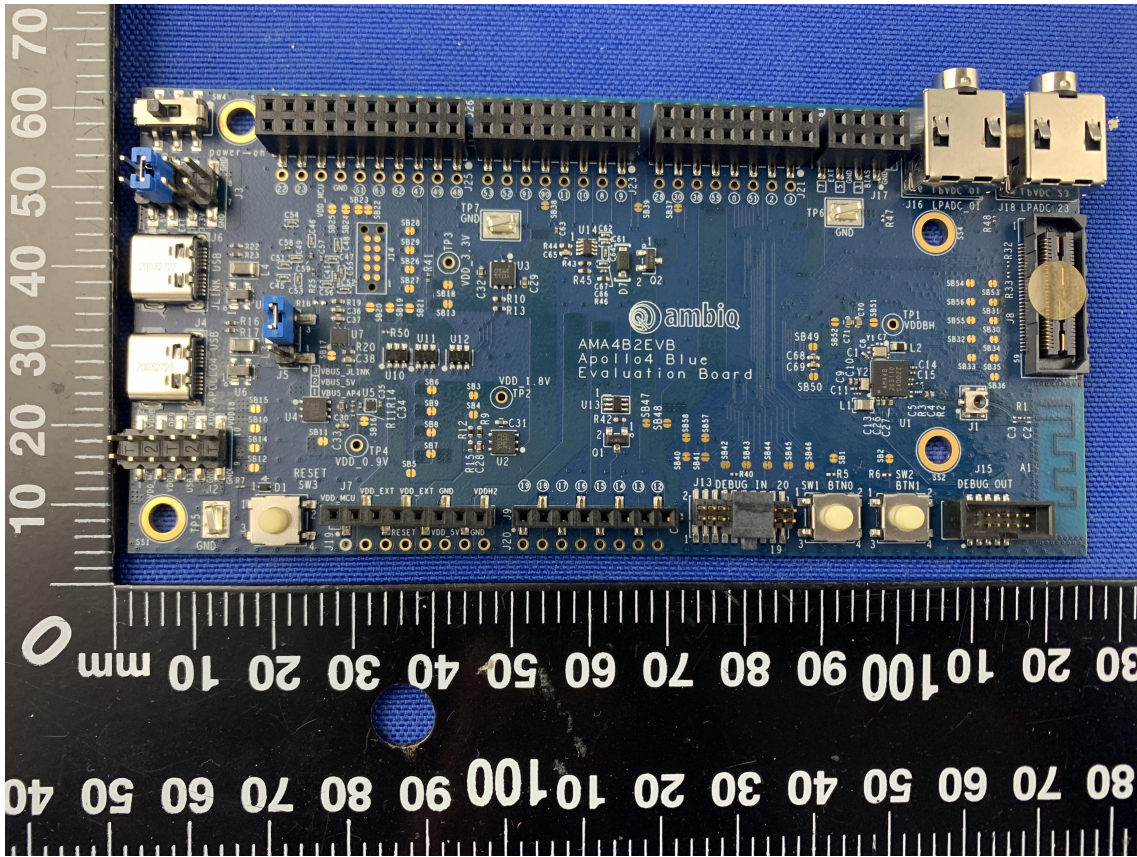
RF-PHY PIXIT				
PIXIT Reference	Identifier	Sub-Identifier (Optional)	Value	Units
RF-PHY:P1:1	Inband Image frequency	Low frequency	-2	MHz
RF-PHY:P1:2		Middle frequency	0	MHz
RF-PHY:P1:3		High frequency	0	MHz
RF-PHY:P2:1	Value n for Intermodulation test	Low frequency	5	Integer
RF-PHY:P2:2		Middle frequency	5	Integer
RF-PHY:P2:3		High frequency	5	Integer
RF-PHY:P4	Power source voltage	Nominal (NOC)	5	V
RF-PHY:P5	Normal Operating temperature	Nominal (NOC)	25	°C
RF-PHY:P6:1	Operating air humidity range (relative)	Maximum	95	%
RF-PHY:P6:2		Minimum	40	%
RF-PHY:P6:3		Air humidity level for NOC tests	40 to 95	%
RF-PHY:P7:1	Test interface implementation	HCI or 2-wire UART	HCI	--
RF-PHY:P7:2		Data Rate	115200	bps
RF-PHY:P9:1	Maximum TX packet length (MAX_TX_LENGTH)	--	37	Bytes
RF-PHY:P9:2	Maximum RX packet length (MAX_RX_LENGTH)	--	37	Bytes
RF-PHY:P9:3	Maximum TX packet length (MAX_TX_LENGTH_2M)	--	37	Bytes
RF-PHY:P9:4	Maximum TX packet length (MAX_TX_LENGTH_CODE D_S2)	--	N/A	Bytes
RF-PHY:P9:5	Maximum TX packet length (MAX_TX_LENGTH_CODE D_S8)	--	N/A	Bytes
RF-PHY:P9:6	Maximum RX packet length (MAX_RX_LENGTH_2M)	--	37	Bytes
RF-PHY:P9:7	Maximum RX packet length (MAX_RX_LENGTH_CODE D_S2)	--	N/A	Bytes
RF-PHY:P9:8	Maximum RX packet length (MAX_RX_LENGTH_CODE D_S8)	--	N/A	Bytes
RF-PHY:P10:1	Maximum TX mode output power	--	4	dBm
RF-PHY:11:1	Inband Image Frequency (2Ms/s)	Low frequency	0	MHz
RF-PHY:11:2		Middle frequency	0	MHz
RF-PHY:11:3		High frequency	0	MHz
RF-PHY:12:1	Value n for Intermodulation test (2Ms/s)	Low frequency	5	Integer
RF-PHY:12:2		Middle frequency	5	Integer

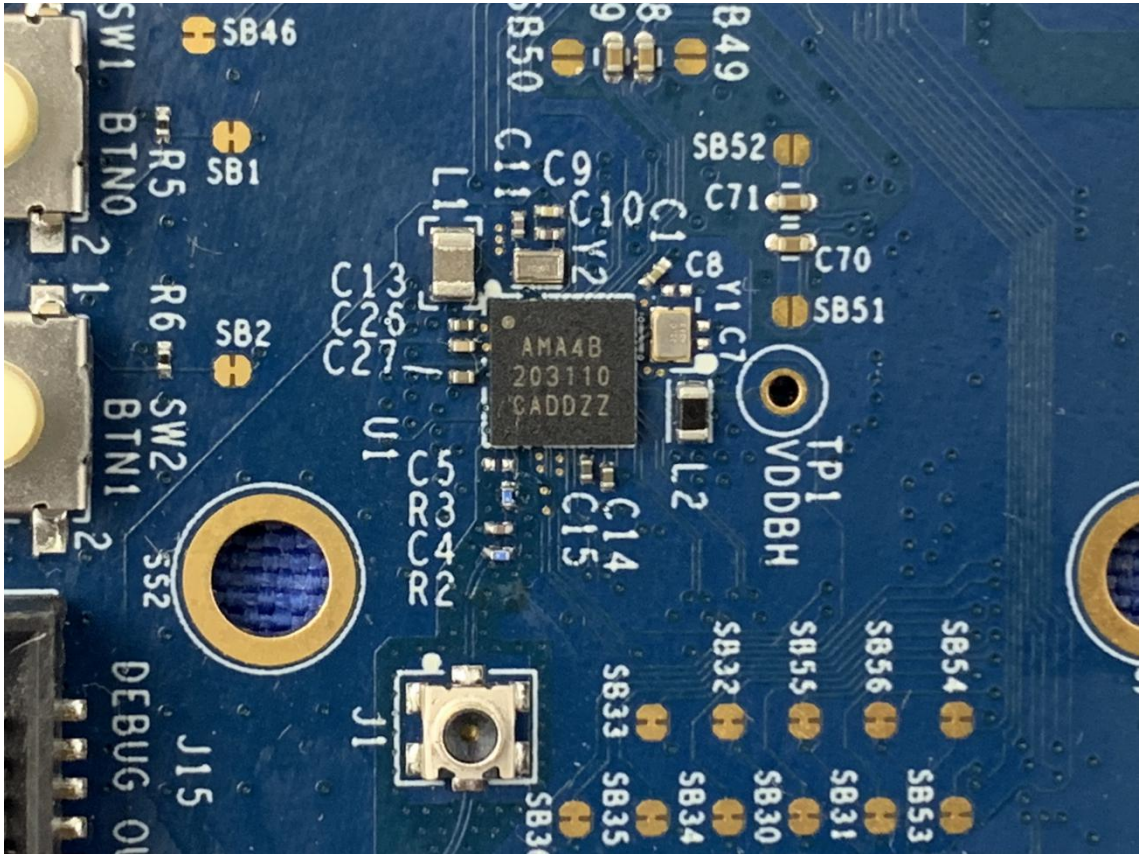
RF-PHY:12:3		High frequency	5	Integer
RF-PHY:13:1	Inband Image Frequency (Stable Modulation Receiver)	Low frequency	N/A	MHz
RF-PHY:13:2		Middle frequency	N/A	MHz
RF-PHY:13:3		High frequency	N/A	MHz
RF-PHY:14:1	Value n for Intermodulation test (Stable Modulation Receiver)	Low frequency	N/A	Integer
RF-PHY:14:2		Middle frequency	N/A	Integer
RF-PHY:14:3		High frequency	N/A	Integer
RF-PHY:15:1	Inband Image Frequency (Stable Modulation Receiver, 2Ms/s)	Low frequency	N/A	MHz
RF-PHY:15:2		Middle frequency	N/A	MHz
RF-PHY:15:3		High frequency	N/A	MHz
RF-PHY:16:1	Value n for Intermodulation test (Stable Modulation Receiver, 2Ms/s)	Low frequency	N/A	Integer
RF-PHY:16:2		Middle frequency	N/A	Integer
RF-PHY:16:3		High frequency	N/A	Integer
RF-PHY:17	IQ Report Rate	--	N/A	--
RF-PHY:18	The length of the Constant Tone Extension(1Ms/s)	--	N/A	bits
RF-PHY:19	The length of the Constant Tone Extension(2Ms/s)	--	N/A	bits
RF-PHY:20	The number of antennae	--	1	--

5.2 Test Results List

Bluetooth Low Energy					
TC. Identifier	Description	Cat.	Verdict	Test Condition	Test Equipment
TRM-LE/CA/BV-01-C	Output power	A	Pass	NTNV	7Layers Systems
TRM-LE/CA/BV-03-C	In-band emissions	A	Pass	NTNV	7Layers Systems
TRM-LE/CA/BV-05-C	Modulation characteristics	A	Pass	NTNV	7Layers Systems
TRM-LE/CA/BV-06-C	Carrier frequency offset and drift	A	Pass	NTNV	7Layers Systems
TRM-LE/CA/BV-08-C	In-band emissions at 2 Ms/s	A	Pass	NTNV	CTTL Systems
TRM-LE/CA/BV-10-C	Modulation Characteristics at 2 Ms/s	A	Pass	NTNV	CTTL Systems
TRM-LE/CA/BV-12-C	Carrier frequency offset and drift at 2 Ms/s	A	Pass	NTNV	CTTL Systems
RCV-LE/CA/BV-01-C	Receiver sensitivity	A	Pass	NTNV	7Layers Systems
RCV-LE/CA/BV-03-C	C/I and receiver selectivity performance	A	Pass	NTNV	7Layers Systems
RCV-LE/CA/BV-04-C	Blocking performance	A	Pass	NTNV	7Layers Systems
RCV-LE/CA/BV-05-C	Intermodulation performance	A	Pass	NTNV	7Layers Systems
RCV-LE/CA/BV-06-C	Maximum input signal level	A	Pass	NTNV	7Layers Systems
RCV-LE/CA/BV-07-C	PER Report Integrity	A	Pass	NTNV	7Layers Systems
RCV-LE/CA/BV-08-C	Receiver sensitivity at 2 Ms/s	A	Pass	NTNV	CTTL Systems
RCV-LE/CA/BV-09-C	C/I and Receiver Selectivity Performance at 2 Ms/s	A	Pass	NTNV	CTTL Systems
RCV-LE/CA/BV-10-C	Blocking performance at 2 Ms/s	A	Pass	NTNV	CTTL Systems
RCV-LE/CA/BV-11-C	Intermodulation performance at 2 Ms/s	A	Pass	NTNV	CTTL Systems
RCV-LE/CA/BV-12-C	Maximum input signal level at 2 Ms/s	A	Pass	NTNV	CTTL Systems
RCV-LE/CA/BV-13-C	PER Report Integrity at 2 Ms/s	A	Pass	NTNV	CTTL Systems

ANNEX A EUT PHOTOS





--END OF REPORT--